BLENNIIDAE ALONG THE ITALIAN COASTS OF THE LIGURIAN AND THE TYRRHENIAN SEA: COMMUNITY STRUCTURE AND NEW RECORDS OF *SCARTELLA CRISTATA* FOR NORTHERN ITALY

by

Jürgen NIEDER (1), Gabriele LA MESA (2) & Marino VACCHI (2)

ABSTRACT. - The assemblages of blenniid fishes were studied by underwater visual methods at 15 rocky shore sites of the coast of Liguria (northern Italy) in 1998 and 10 sites along the Ligurian and Tyrrhenian Sea (west coast of Italy) in 1989 and 1990. A total of 12 species was found, with little variation in species composition among sites. Fish density ranged from 0.4 to 0.9 individuals/m^2. Simi-larity among the sampling sites of Tyrrhenian Sea followed a geographical latitudinal gradient (north-south). The study at a smaller spatial scale in the Ligurian Sea showed that both geographical distance and environmental features influence the similarity among sites. The presence of *Scartella cristata* at 21 out of 25 sampling stations indicate that this species, which formerly did not occur in the northern Mediterranean, is now firmly established in the coastal waters of Italy. These findings provide additional evidence of a notable and rapid biological modification in coastal fish communities, probably related to temperature increase of the Mediterranean Sea.

RÉSUMÉ. - Blenniidae des côtes italiennes des mers Ligure et Tyrrhénienne: structure des communautés et nouvelles signalisations de *Scartella cristata* au nord de l'Italie.

Les communautés de Blenniidae ont été étudiées par des méthodes visuelles en plongée le long de la côte nord-ouest de l'Italie, dans 16 stations en Mer ligurienne et 9 en Mer tyrrhénienne. Au total, 12 espèces ont été répertoriées, avec une composition spécifique variant peu entre les différentes stations. La densité variait de 0.4 à 0.9 individus/m^2. Le degré de similitude entre les stations de la Mer tyrrhénienne suit un gradient géographique (nord-sud). Des analyses à plus petite échelle le long de la côte ligurienne ont montré l'influence des facteurs soit géographiques, soit environnementaux sur la similitude entre stations. La présence de *Scartella cristata* dans 21 des 25 stations montre que cette espèce, qui n'avait jamais été répertoriée dans les régions nord méditerranéennes, est devenue un élément bien stable des communautés côtières du nord de l'Italie. Cette présence indique que d'importantes modifications ont lieu rapidement dans les communautés côtières de poissons, probablement en relation avec l'augmentation de la température de la Méditerranée.

Key words. - Blenniidae - *Scartella cristata* - MED - Tyrrhenian Sea - Ligurian Sea - Visual census - Community structure.

Combtooth blennies (Blenniidae) are well represented in the Mediterranean: 19 species are documented, mostly in the littoral zone along rocky shores (Zander, 1972a). Here, blenniids are the richest family in species and they are the most abundant benthic

(1) Botanisches Institut der Universität Bonn, Meckenheimer Allee 170, 53115 Bonn, GERMANY. [jnieder@uni-bonn.de]

(2) ICRAM, Istituto Centrale per la Ricerca scientifica e tecnologica Applicata al Mare.Via di Casalotti 300, I-00166 Roma, ITALY. [vacchim@tin.it]

Cybium 2000, 24(4): 359-359.

Fig. 1. - Study area and location of Tyrrhenian sampling sites.

fishes. Because they lack economic value (they are usually not even caught by anglers), they are not directly affected by human activity and, in consequence, they are well suited for diversity studies.

Combtooth blennies use holes and crevices as shelters, mostly on steep rock walls. Apart from Tripterygiidae (similar to blennies in feeding, habitat requirements and size) and Scorpaenidae (much larger predators), practically no other benthic fish occupies this littoral habitat (Gobiidae generally prefer sandy bottoms, see Zander, 1996). Blennies therefore constitute a community in the wider sense of the term or an "assemblage", if one prefers to use the term community for the biotic component of a whole ecosystem (Giller, 1984).

The occurrence of Blenniidae along the Italian coast has not been specifically dealt with in a publication. However, many systematic or ecological papers focus on Italian blenniids (e.g., Vinciguerra, 1879; Abel, 1961). Papaconstantinou (1974) has described the blenniids from some sites in the Ligurian Sea.

In general, accounts of Blenniidae along the Italian coasts are rare and of a qualitative nature (Catalano, 1975; Balma and Delmastro, 1984). Few studies list the different blenniid species of specific sites. Segantin (1968) and Patzner (1985) give descriptions of the typical habitats of different species, but no census data are included, which would allow an analysis of the blenniid assemblage structure.

Two blenniid species in particular were the subject of several papers: *Scartella cristata* and *Parablennius pilicornis*. De Leo *et al*. (1976) and Catalano *et al*. (1985) dis-

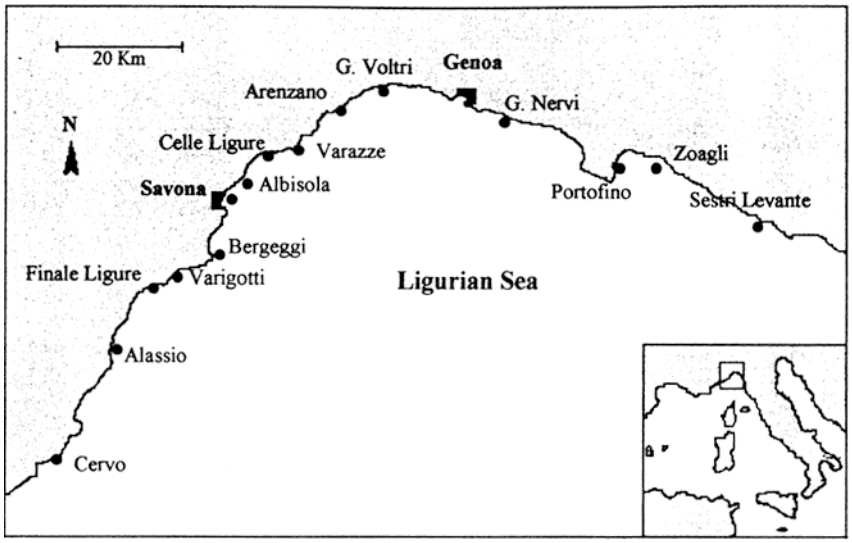

Fig. 2. - Study area and location of Ligurian sampling sites.

covered both species in Sicily, although they were previously thought only to occur in the southern Mediterranean Sea (apart from their presence in the Atlantic Ocean; see Zander, 1972b). Their results fit well into the emerging picture of a much more northerly distribution of these two species than previously recorded (Motos and Ibañez, 1977; Denoix, 1984; Mercader-Bravo, 1988; Nieder, 1988). *S. cristata* was even found near Genova (Balma and Delmastro, 1984).

Our aims are to present data on the abundances and community structures of blenniids at different sites of the Ligurian and the Tyrrhenian Sea along the western coast of Italy, and to give evidence of the soundly established occurrence of *S. cristata*.

MATERIAL AND METHODS

Underwater inspections of sections along the coast of Tyrrhenian Sea were carried out in July 1989 (at Moneglia, Livorno, Castiglione, Porto S. Stefano, S. Marinella, Monte Circeo, Sorrento, Marina di Camerota and Capo Vaticano), February 1990 (at Moneglia) and April 1990 (at Tellaro) (Fig. 1).

Visual censuses of randomly selected sections of 1.50 m length and 1.50 m depth (where possible), equivalent to 2.25 m^2, were carried out, a method similar to that described in Zander and Hartwig (1982). Measuring tape was used to determine the exact length of observation sections. Blenniids on the surface of the substrate and those detec-table in holes and crevices were counted. In order to minimise errors because of indivi-duals entering or leaving the observed section, observation time was restricted to 10 minutes per section.

Thus a total of 305.5 m of rocky shore length from the surface down to 1.50 m were studied.

From July to October 1998, we surveyed the blenniid assemblages at 15 sampling sites located along the Ligurian coasts (Fig. 2). Along a 50 x 2.5 m randomly placed transect, blenniids were visually censused, within 0 - 1.5 m depth range, once per site. For each tran-

sect, all the observed individuals of *S. cristata* were counted and sized, whereas the other blenniid species were assigned to three abundance classes (1, 2-9, > 9 individuals). A description of the physical and biological features of the transect environment was made by estimating the bottom topography, the substrate type, and the dominant sessile organisms (Table I). Moreover, a 4-point scale of verticality was used to categorise the general slope of the transect (Harmelin-Vivien *et al*., 1995).

Due to differences in sampling methodology, data collected in 1989-1990 (quantitative censuses) and 1998 (semi-quantitative censuses) were separately analysed. The blenniid assemblages studied in 1989-1990 were compared by means of Morisita's index of similarity (C_λ), the most reliable test for this purpose (Krebs, 1999):

$$C_\lambda = \frac{2\Sigma X_{ij} X_{ik}}{(\lambda_1 + \lambda_2) N_j N_k}$$

where

C_λ = Morisita's index of similarity between sample j and k; X_{ij}, X_{ik} = number of individuals of species i in sample j and sample k; $N_j = \Sigma X_{ij}$ = total number of individuals in sample j; $N_k = \Sigma X_{ik}$ = total number of individuals in sample k.

$\lambda_1 = \sum^n [X_{ij} (X_{ij} - 1)] / N_j (N_j - 1)$;

$\lambda_2 = \sum^n [X_{ik} (X_{ik} - 1)] / N_k (N_k - 1)$.

Moreover, abundance of blenniid species in the sampling stations (except the sample collected on February at Moneglia) were compared by means of a 2-factor analysis, supplied by Statistica 5.0 software packages.

The patterns of similarity of the blenniid assemblages and the environmental features at the Ligurian sites studied in 1998 were evaluated by means of a cluster analysis, using the complete linkage clustering procedure supplied by SPSS software packages.

Table I. - Bottom features and dominant sessile organisms in the Ligurian study sites.

Sites	Topography	Substrate	Slope	Dominant sessil organisms
Sestri Levante	Reef	Solid rock	Medium	Mussels; Photophilic algae
Zoagli	Reef	Solid rock	Medium	Mussels; Photophilic algae
Portofino	Cliff	Solid rock	Steep	Mussels; Photophilic algae
Genova Nervi	Reef	Solid rock	Medium	Mussels; Photophilic algae
Genova Voltri	Reef	Blocks	Gentle	Mussels; Barnacles; Serpulids
Arenzano	Artificial reef	Blocks	Gentle	Mussels; Barnacles
Varazze	Reef	Solid rock	Medium	Mussels; Photophilic algae
Celle Ligure	Reef	Solid rock	Medium	Mussels; Photophilic algae
Albisola	Cliff	Solid rock	Medium	Photophilic algae
Savona	Reef	Blocks	Medium	Mussels
Bergeggi	Cliff	Solid rock	Steep	Photophilic algae; Sponges
Varigotti	Cliff	Solid rock	Abrupt	Photophilic algae; Sponges
Finale Ligure	Artificial reef	Blocks	Gentle	Mussels; Barnacles
Alassio	Reef	Solid rock	Medium	Photophilic algae;
Cervo	Reef	Blocks	Gentle	Photophilic algae; Mussels

RESULTS

At the Tyrrhenian sites a total of 1061 blennies belonging to nine species were observed (Tables II, III). Most species were present at every site, with the exception of *Parablennius sanguinolentus*, which usually occurs along shore sections with loose boulders on the bottom (Zander, 1972), often in shallow bays, a habitat poorly investigated in the present survey. *Parablennius incognitus* was the most abundant species, followed by *Lipophrys canevae* and *L. trigloides*.

Table II. - Length of shore sections and abundance (number of individuals) of all blennies in the Tyrrhenian study sites.

Sites	Coastal section length (m)	N. of blennies individuals			N. of *S. cristata* individuals		% *S. cristata* of blennies
		Total	/10 m	/10 m^2	Total	/10 m	
Moneglia (February)	59.0	58	9.8	6.6	0	0.0	0.0
Moneglia (July)	25.5	79	31.0	20.7	8	3.1	10.1
Tellaro	6.0	60	100.0	66.7	1	1.7	1.7
Livorno	25.0	152	60.8	40.5	11	4.4	7.2
Castiglione	15.5	200	129.0	86.0	7	4.5	3.5
S. Stefano	6.0	61	101.7	67.8	2	3.3	3.3
S. Marinella	9.0	26	28.9	19.3	5	5.6	19.2
Monte Circeo	37.5	214	57.1	38.0	34	9.1	15.9
Sorrento	18.0	68	37.8	25.2	13	7.2	19.1
M. Camerota	31.5	106	33.7	22.4	0	0.0	0.0
Capo Vaticano	72.5	37	5.1	3.4	7	1.0	18.9
Total	305.5	1061			88		

Table III. - Blenniid species abundance (as percentage of total number of Blenniids) at the Tyrrhenian study sites. Mon1: Moneglia (February); Mon2: Moneglia (July); Tel: Tellaro; Liv: Livorno; Cas: Castiglione; Ste: S. Stefano; Mar: S. Marinella; Cir: Monte Circeo; Sor: Sorrento; Cam: M. Camerota; Vat: Capo Vaticano.

Species	Sites											
	Mon1	Mon2	Tel	Liv	Cas	Ste	Mar	Cir	Sor	Cam	Vat	Total
Aidablennius sphynx	22.4	5.1	1.7	9.9	2.5	8.2	15.4	1.9	1.5	15.1	2.7	69
Coryphoblennius galerita	0.0	8.9	3.3	7.2	12.5	0.0	3.8	10.7	1.5	21.7	27.0	103
Lipophrys canevai	5.2	12.7	21.7	19.1	16.0	19.7	23.1	14.0	27.9	18.9	2.7	175
Lipophrys trigloides	5.2	10.1	6.7	17.8	17.0	9.8	3.8	22.4	4.4	17.0	32.4	164
Parablennius gattorugine	5.2	6.3	1.7	0.0	6.5	3.3	3.8	9.8	5.9	2.8	8.1	56
Parablennius incognitus	62.1	40.5	58.3	30.3	24.0	37.7	26.9	22.4	23.5	11.3	5.4	305
Parablennius sanguinolentus	0.0	0.0	0.0	2.6	0.0	0.0	0.0	2.8	1.5	1.9	0.0	13
Parablennius zvonimiri	0.0	6.3	5.0	5.9	18.0	18.0	3.8	0.0	14.7	11.3	2.7	88
Scartella cristata	0.0	10.1	1.7	7.2	3.5	3.3	19.2	15.9	19.1	0.0	18.9	88
Total number of blenniids	58	79	60	152	200	61	26	214	68	106	37	1061

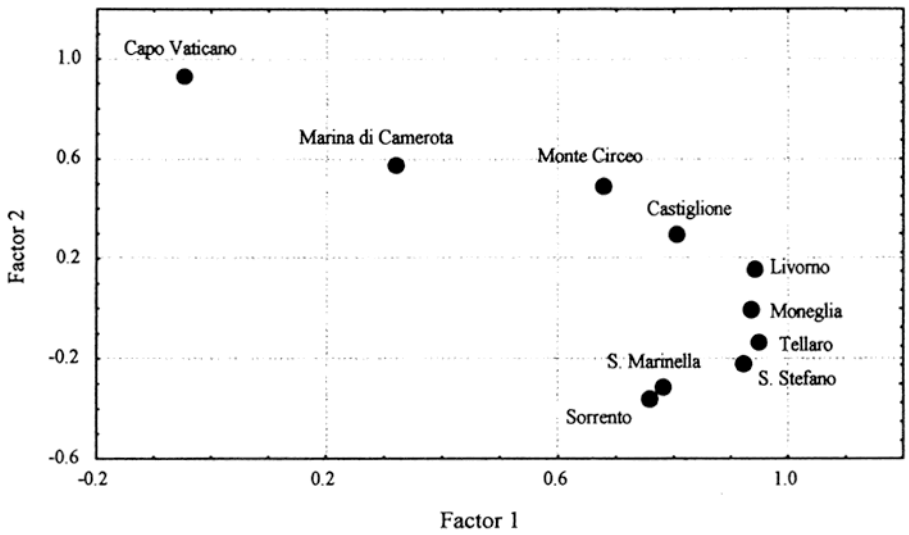

Fig. 3. - Two factor analysis for the benthic fish assemblages (10 sites as variables, abundances of blenny and *Tripterygion* individuals used for the data matrix; Eigenvalues: 5.92 (Factor 1) and 1.83 (Factor 2). Together both factors account for 77% of the variance.

Total abundance of blenniids was highest at Castiglione, Porto S. Stefano and Tellaro, with 129, 102 and 100 individuals per 10 m shoreline, respectively (Table II). At the other sites abundances were much lower, with a minimum at Capo Vaticano, where only 37 blenniids were found on 72.5 m of shoreline.

Although blenniid assemblages seemed highly variable at first sight (Table III), Morisita's index of similarity (Table IV) and a 2-factor-analysis (Fig. 3) showed a clear structure: neighbouring sites were more similar to each other than to distant ones. The two southernmost sites, Marina di Camerota and Capo Vaticano, were remarkably isolated from the other sites. The latitudinal gradient most likely accounts for factor 1 in the 2-factor analysis, visible as an arrangement of the southernmost sites on the left and the northern sites on the right. This factor accounts for approximately 59% of the variability

Table IV. - Morisita's similarity indices of blenny assemblages at the Tyrrhenian study sites. See abbreviations of sites name in table III.

Sites	Mon1	Mon2	Tel	Liv	Cas	Ste	Mar	Cir	Sor	Cam	Vat
Mon1		0.86	0.93	0.77	0.60	0.84	0.72	0.58	0.56	0.41	0.20
Mon2			0.91	0.96	0.88	0.95	0.97	0.87	0.85	0.68	0.55
Tel				0.85	0.73	0.93	0.75	0.68	0.75	0.43	0.24
Liv					0.93	0.96	0.96	0.91	0.86	0.75	0.61
Cas						0.93	0.80	0.86	0.85	0.78	0.66
Ste							0.90	0.76	0.91	0.61	0.34
Mar								0.85	0.98	0.78	0.53
Cir									0.80	0.66	0.84
Sor										0.57	0.42
Cam											0.77
Vat											

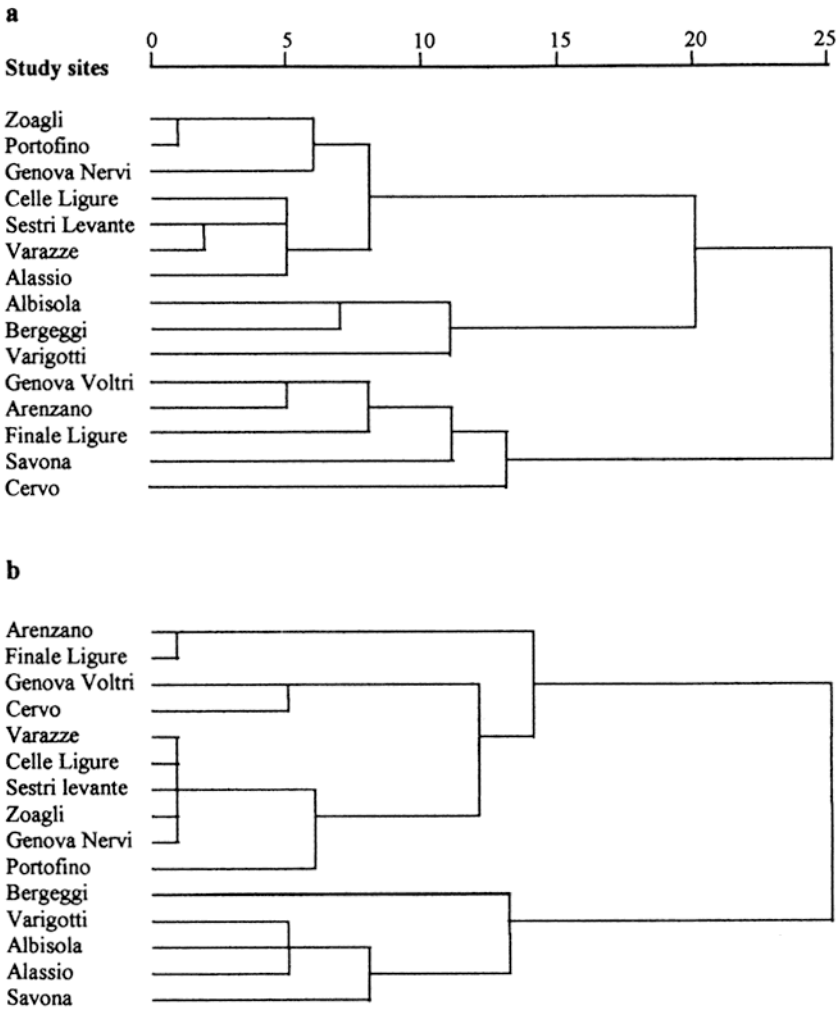

Fig. 4. - Cluster analysis of the Ligurian study sites on the basis of blenny assemblage (**a**) and of abiotic parameters (**b**). Diagrams result from complete linkage clustering, using Minkowski distance to measu-re similarity.

of the benthic fish assemblages. Interestingly, this corresponds to the increase of similarity indices from southern to northern sites, shown in table IV. We have yet no indication as to what accounts for factor 2.

In all, 12 blenny species were censused at the Ligurian study sites (Table V). Cluster analysis applied on blenny assemblages grouped the Ligurian samples into three clusters (Fig. 4a). The pattern of similarity among the Ligurian sites concerning their environmental features was quite comparable (Fig. 4b). Blenny assemblages of neighbouring sites characterised by common abiotic features generally showed an high similarity (see clusters with Sestri Levante and Albisola, Fig. 4a). Some sampling sites very far from each other grouped in the

same cluster as well (namely Arenzano and Finale Ligure, Fig. 4a), probably owing to their similar environmental characteristics (Fig. 4b).

S. cristata was sighted at 12 out of 15 Ligurian sites. Its abundances showed an high variability, ranging from just one (Savona) to 36 (Portofino) individuals per transect (Table V).

South of Liguria, *S. cristata* was found at 7 out of 8 sites. It was significantly more abundant at the southern sites (Table II). Whereas north of S. Marinella relative frequencies (% of all individuals) of this species never exceeded 10.1%, the four sites in southern Italy (with the striking exception of Marina di Camerota) all had more than 15% *S. cristata* in all individuals (t-value: 2.31949, $p < 0.05$).

DISCUSSION

The high abundance of blennies along the Tyrrhenian coast seems surprising at first, but there are similar data for the Adriatic: near Rovinj the total abundance of blenniids was 40 individuals/10 m^2 (Illich and Kotrschal, 1990). This figure roughly corres-ponds to most sites we sampled (Table II).

As in Rovinj, *P. incognitus* dominated the blenniid assemblages of our sampling sites. The main differences to Rovinj were the high abundance of *P. tentacularis* and the lack of *S. cristata* at Rovinj.

In contrast, Spyker (1995) reported a low average number of blenniids along a 30 m transect on the coast of Corsica (less than 2 individuals per transect). This is a eighth of the lowest abundance of this study (Capo Vaticano, 0.5 individuals per m coastline), but probably a rapid censusing technique accounts for the striking differences.

The abundances found by Macpherson (1994) on the coast of northeastern Spain are similar to our results (e.g., at Blanes 5.14 individuals/m^2; seven blenniid species).

Table V. - Blenniid species abundance (as total number of individuals per 50 x 2.5 m transect) at the Ligurian study sites. Sle: Sestri Levante; Zoa: Zoagli; Por: Portofino; Gne: Genova Nervi; Gvo: Genova Voltri; Are: Arenzano; Vaz: Varazze; Cli: Celle Ligure; Alb: Albisola; Sav: Savona; Ber: Bergeggi; Var: Varigotti; Fli: Finale Ligure; Ala: Alassio; Cer: Cervo.

Species	Sites														
	Sle	Zoa	Por	Gne	Gvo	Ar	Vaz	Cli	Alb	Sav	Ber	Var	Fli	Ala	Cer
Aidablennius sphinx	2-9	2-9	> 9	> 9	> 9	2-9	2-9	2-9	2-9	> 9	2-9	> 9	> 9	2-9	> 9
Coryphoblennius galerita	2-9	2-9	2-9	2-9	1	1	2-9	1	> 9	1	2-9	> 9	1	2-9	0
Lipophrys canevai	2-9	> 9	> 9	> 9	1	0	2-9	> 9	2-9	0	> 9	> 9	1	1	2-9
Lipophrys dalmatinus	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lipophrys nigriceps	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Lipophrys trigloides	2-9	> 9	> 9	2-9	2-9	1	2-9	> 9	> 9	> 9	> 9	1	2-9	> 9	> 9
Parablennius gattorugine	1	1	2-9	2-9	2-9	1	1	2-9	2-9	2-9	2-9	1	0	2-9	1
Parablennius incognitus	> 9	> 9	> 9	2-9	2-9	2-9	> 9	> 9	> 9	> 9	> 9	2-9	> 9	> 9	1
Parablennius rouxi	0	0	0	0	0	0	0	0	0	0	2-9	1	0	0	0
Parablennius sanguinolentus	1	0	0	0	> 9	> 9	0	0	0	2-9	0	1	2-9	1	2-9
Parablennius zvonimiri	1	2-9	2-9	1	0	0	1	0	2-9	1	2-9	2-9	0	1	1
Scartella cristata	2	12	36	11	20	4	15	20	0	1	0	0	10	23	13

The differences in abundance of small benthic fishes at different sites have been attributed to presence or absence of large predators (Macpherson, 1994) because of different conservation status of the respective areas. Our results show striking differences for unprotected areas. Therefore it is likely that other factors contribute considerably to the differences in abundance, in particular settlement success and recruitment levels. The type of substrate cover is decisive for blenniid settlement (Macpherson, 1999). Production of small fishes is correlated to the production of epifauna (Edgar, 1995), which does not develop on little structured rock surfaces with scarce algal cover. Together with a lack of suitable holes and clefts, these conditions probably prevent the establishment of an abundant community of benthic fishes.

Concerning species composition and relative abundances, our results allow some tentative conclusions about the mechanisms that shape blenniid assemblages:

1. The regular occurrence of all species at all of the investigated sites (with a few exceptions) and the relatively high similarity between sites in general indicate that the composition of blenniid assemblages on the Italian coast is a result of deterministic processes. This view is supported by the apparent stability of these assemblages, which was found for Adriatic (Illich and Kotrschal, 1990) and Caribbean blenniids (Greenfield and Johnson, 1990). Possibly, this is a general characteristic of rocky fish assemblages (Grossman, 1982).

2. The differences in assemblage composition among the Ligurian sites and along a north-south gradient down to the coast of Calabria and the marked similarity often observed between neighbouring sites with similar substrate properties are striking. They indicate that once the rocky substrate, as a major feature of typical blenniid habitats are given, microhabitat differences (e.g., type of rock, slope, sessile organisms) affect the abundance of blenniids as a whole and the relative importance of single species.

3. Large-scale changes suggest the importance of geographical differences, most likely water temperatures. Both the frequent occurrence and the high abundance of *S. cristata* even in Liguria support this view. This species was not present at Diano Marina in 1975 and Santa Margherita Ligure in 1979 (R. Fricke, pers. comm.). It is possible that a gradual warming of water temperatures (Bethoux *et al*., 1998; Krahmann and Schott, 1998) is responsible for the remarkable recent expansion of the range of this and other marine species (Francour, 1994; Astraldi, 1995). A similar process of changes in the composition of coastal fish faunas has occurred in California (Barry *et al*., 1995; Holbrook *et al*., 1997). One cannot exclude, however, that *S. cristata* is at present in the process of general expansion of its distribution in the Mediterranean Sea.

The present data are not yet sufficient to exhaustively prove the above stated conclusions. Unfortunately, the general lack of quantitative data for the past does not allow to reconstruct the faunal changes in the littoral fish communities of Italy. Future studies could at least corroborate our assumptions on the basic mechanism that determine the blenniid assemblage composition on Italian rocky shores.

Acknowledgements. - C.D. Zander (Hamburg) accompanied and supported the initial work on Blenniidae in 1989 and 1990. Without his help and expertise it could not have been finished. We thank him very much. A first draft of this paper was corrected by two anonymous reviewers, giving valuable comments, for which we thank them. Thanks also to R. Fricke (Stuttgart), who provided additional information on the distribution of *Scartella cristata* and improved the manuscript by proposing a number of important changes.

REFERENCES

ABEL E.F., 1961. - Über die Beziehungen mariner Fische zu Hartbodenstrukturen. *Sitz. ber. Österr.. Akad. Wiss. Math. - Nat. Kl.*, Abt. I, 170: 223-263.

ASTRALDI M., BIANCHI C.N., GASPARINI G.P. & C. MORRI, 1995. - Climatic fluctuations, current variability and marine species distribution: A case study in the Ligurian Sea (north-west Mediterranean). *Oceanol. Acta*, 18: 139-149.

BALMA G.A.C. & G.B. DELMASTRO, 1984. - *Scartella cristata* (L., 1758), blennide nuovo per la fauna del Mar Ligure (Osteichthyes, Blenniidae). *Doriana*, 6: 1-5.

BARRY J.P., BAXTER C.H., SAGARIN R.D. & S.E. GILMAN, 1995. - Climate-related, long-term faunal changes in a California rocky intertidal community. *Science*, 267: 672-675.

BETHOUX J.P., GENTILI B. & D. TAILLIEZ, 1998. - Warming and freshwater budget change in the Mediterranean since the 1940s, their possible relation to the greenhouse effect. *Geophys. Res. Lett.*, 25: 1023-1026.

CATALANO E., 1975. - Osservazioni su alcune catture di pesci del Golfo di Palermo. *Pubbl. Staz. Zool. Nàpoli*, 39: 36.

CATALANO E., VITTURI R., ZAVA B. & M. MACALUSO, 1985. - Ritrovamento di *Parablennius pilicornis* (Cuvier, 1829) nelle acque italiane e suo cariotipo (Pisces Blenniidae). *Atti Soc. Ital. Sci. Nat. Museo Civ. Stor. Nat. Milano*, 126: 155-164.

DE LEO G., CATALANO E. & N. PARINELLO, 1976. - Contributo alla conoscenza del *Blennius cristatus* L., 1758 (Perciformes, Blenniidae). *Mem. Biol. Mar. Ocean.*, 6: 209-228.

DENOIX M., 1984. - Zur Biologie des Schleimfisches *Parablennius pilicornis* Cuvier 1829 (Blenniidae, Perciformes) unter besonderer Berücksichtigung der sekundären Geschlechtsmerkmale des Männchens nach Hormonbehandlung. 114 p. Dissertation Univ. Tübingen.

EDGAR G.J. & C. SHAW, 1995. - The production and trophic ecology of shallow-water fish assemblages in southern Australia. 1. Species richness, size-structure and production of fishes in Western Port, Victoria. *J. Exp. Mar. Biol. Ecol.*, 194: 53-81.

FRANCOUR P., BOUDOURESQUE C.F., HARMELIN J.G., HARMELIN-VIVIEN M.L. & J.P. QUIGNARD, 1994. - Are the Mediterranean waters becoming warmer? Information from biological indicators. *Mar. Poll. Bull.*, 28(9): 523-526.

GILLER P.S., 1984. - Community Structure and the Niche. 176 p. New York: Chapman and Hall.

GREENFIELD D.W. & R.K. JOHNSON, 1990. - Community structure of western Caribbean blennioid fishes. *Copeia*, 2: 433-448.

GROSSMAN G.D., 1982. - Dynamics and organisation of a rocky intertidal fish assemblage: The persistence and resilience of taxocene structure. *Am. Nat.*, 119: 611-637.

HARMELIN-VIVIEN M.L., HARMELIN J.G. & V. LEBOULLEUX, 1995. - Microhabitat requirements for settlement of juvenile sparid fishes on Mediterranean rocky shores. *Hydrobiologia*, 300/301: 309-320.

HOLBROOK S.J., SCHMITT R.J. & J.S. STEPHENS Jr., 1997. - Changes in an assemblage of temperate reef fishes associated with a climate shift. *Ecol. Appl.*, 7: 1299-1310.

ILLICH I.P. & K. KOTRSCHAL, 1990. - Depth distribution and abundance of northern Adriatic littoral rocky reef blennioid fishes (Blenniidae and *Tripterygion*). *P.S.Z.N. I: Mar. Ecol.*, 11: 277-289.

KRAHMANN G. & F. SCHOTT, 1998. - Longterm increases in Western Mediterranean salinities and temperatures: anthropogenic and climatic sources. *Geophys. Res. Lett.*, 25: 4209-4212.

KREBS J.R., 1999. - Ecological Methodology. 620 p. Menlo Park (California): Addison Wesley Longman.

MACPHERSON E., 1994. - Substrate utilisation in a Mediterranean littoral fish community. *Mar. Ecol. Prog. Ser.*, 114: 211-218.

MACPHERSON E. & U. ZIKA, 1999. - Temporal and spatial variability of settlement success and recruitment level in three blennoid fishes in the northwestern Mediterranean. *Mar. Ecol. Prog. Ser.*, 182: 269-282.

MERCADER-BRAVO L., 1988. - *Parablennius pilicornis* (Cuvier, 1829) (Pisces, Blenniidae), primera citació pel mar catalá (Mediterrània NO). *Misc. Zool.*, 12: 374-378.

MOTOS L. & M. IBAÑEZ, 1977. - *Blennius pilicornis* Cuvier 1829 ssp. nov. *euskalherriensis*, especie nueva para el litoral de la costa vasca y descripción de una subespecie. *Munibe*, 29: 231-236.

NIEDER J., 1988. - Zum Vorkommen von *Scartella cristata* (L.) und *Parablennius pilicornis* (Cuv.) (Teleostei, Blenniidae) an der nordspanischen Mittelmeerküste. *Zool. Anz.*, 220: 144-150.

PAPACONSTANTINOU K., 1974. - Osservazioni ecologiche intorno ai blennidi del Golfo di Genova (Pisces Perciformes). *Doriana*, 5: 1-4.

PATZNER R.A., 1985. - The blennies (Pisces, Blennioidea) at the marine biological station of Aurisina (Gulf of Triest, Italy). *Nova Thalassia*, 7: 107-119.

SEGANTIN G.M., 1968. - I Blenniidae del litorale Veneto. *Boll. Mus. Civ. Stor. Nat. Venezia*, 18: 41-68.

SPYKER K.A. & E.P. VAN DEN BERGHE, 1995. - Diurnal abundance patterns of Mediterranean fishes assessed on fixed transects by scuba divers. *Trans. Am. Fish. Soc.*, 124: 216-224.

VINCIGUERRA D., 1879. - Appunti ittiologici. Sulle collezioni del Museo Civico di Genova. III. Intorno ai Blennioidei del golfo di Genova. *Ann. Mus. Civ. Stor. Nat. Genova*, 15: 430-453.

ZANDER C.D., 1972a. - Beiträge zur Ökologie und Biologie von Blenniidae (Pisces) des Mittelmeeres. *Helgol. wiss. Meeresunters.*, 23: 193-231.

ZANDER C.D., 1972b. - Zur Verbreitungsgeschichte der Gattung *Blennius* (Blennioidei, Pisces). *Mitt. Hamburg. Zool. Mus. Inst.*, 68: 213-230.

ZANDER C.D., 1996. - The distribution and feeding ecology of small-size epibenthic fish in the coastal Mediterranean Sea. *In:* Biology and Ecology of shallow coastal Waters (Eleftheriou A., ed.), pp. 369-376. Fredensbourg: Olsen & Olsen.

ZANDER C.D. & E. HARTWIG, 1982. – On the biology and food of small-sized fish from the North and Baltic Sea areas. IV. Investigations on an eulittoral mud flat at Sylt. *Helgol. wiss. Meeresunters.*, 35: 47-63.

Reçu le 07.03.2000.
Accepté pour publication le 29.08.2000.